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# Towards system for the management of safety on board artisanal fishing vessels: Proposal for check-lists and their application

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ABSTRACT

The safety management systems applied at the international level in merchant vessels do not have their equivalent in the vessels dedicated to fishing, and much less to the most numerous sub-sector, artisanal fishing. The article presented here is based on the results of a research project conducted to assess the degree of safety existing in the artisanal fishing fleet of Andalusia, in SW Spain. It offers a set of proposals aimed at improving safety by the production and application of check-lists, as stated in the initial objectives of the project. We therefore present a series of specific working instruments for the detection and correction of the various risks that are frequently faced in the artisanal fisheries sector; these instruments have, in fact, already been applied by the Regional Authorities in the form of risk assessment models, which we present here.



## 1. Introduction

### 1.1. Safety hazards in the fishing sector

Fishing is one of the most hazardous sectors of industry. Occupational injuries are more frequent than in any other profession; for example in Spain, the rate of fatal accidents was, in 2004, over 59.4 per 100,000 workers for sea fishermen and only 6.8 in other occupations.[1] Various studies have confirmed this statement for other countries (Chauvin and Le Bouar, 2007; Wang et al., 2005; Matheson et al., 2001; Antao et al., 2008). Numerous regional, national and international institutions have approached this topic by means of the adoption of particular policies for the prevention of accidents and injury (IMO, 1999; ILO, 1999; Centro Naval, 2006). For example, the Economic and Social Commission of the European Union on Safety and Health in the work of fishermen has established that fishing is the most dangerous of all the principal branches of economic activity; ten times more fatal accidents are recorded in fishing than in any of the other sectors with high risk factors (mining, construction and agriculture) (EU, 2002).

Under the SEGUMAR – Final Report Research Project (Fig. 1), which has European financing, our research group has undertaken various studies analysing the health and safety situation in the sector of the artisanal fishing fleet in the region of Andalusia, Spain, and has published its results in several articles, some in this same journal (Piniella et al., 2008), that demonstrate how these hazards are quantitatively even more serious in the fleet of smaller boats operated on a family basis (Piniella et al., 2007). We have also analysed the different risks for each of the artisanal fishing techniques used and their influence on the number of accidents that take place (Piniella, 2007), and have been able to confirm that these boats generally do not have plans for accident prevention on board, nor systems for managing their activity in respect of either safety or quality.

### 1.2. Limitations of the existing policies for safety in the fishing fleet

At the international level, organisations such as the International Maritime Organization (IMO), the International Labour Organization (ILO), and the UN Food and Agriculture Organization (FAO) have played a fundamental role in the development of regulatory measures in relation to the safety of the fishing fleet (Ben-Yami, 2000; FAO, 1995, 2000, 2005). The most significant successes of these policies have been the Torremolinos Convention and the Code for Responsible Fishing (IMO, 1977). But unfortunately there have been many attempts that have become bogged down in the final stages of securing the implementation of their worthy policies; this is the case of the International Convention on Standards of Training, Certification and Watch-keeping for Seafarers, for fishing vessels (STCW-F 95) (IMO, 1978–1995, 1993a, 1995). The specialist Agencies of the United Nations are aware of how difficult it

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**Fig. 1.** Collection of datas.

is actually to implement such policies; evidence of this can be found in the approved document titled Guidance Document on Fishermens' Training and Certification, produced jointly by the IMO, FAO and ILO which was approved in 1995 and redrafted in the year 2000. The Torremolinos Convention itself is also limited in respect of the effectiveness of the measures, since the vessels to which it applies, those of at least thirty metres in length, in reality represent only a very minor proportion of the total fleet. Somewhat less restricted, but still not generally applicable, is the STCW-F 95 Convention, the area of application of which excludes fishing vessels of less than 24 m in length. This problem has also been highlighted by a previous study (Morel et al., 2008).

There is a clear evidence, therefore, of inequality between merchant vessels and fishing vessels in the application of the international safety standards. Whereas the important agreements apply to much more than 90% of large vessels, the fleet dedicated to commercial fishing remains outside this normative framework. The most important of these regulations, the International Convention for Safety of Life at Sea (SOLAS 74) (IMO, 1974), applies to merchant vessels on international voyages, and only its philosophy is applied, by analogy and at the national level, to fishing vessels, as is the case of Spain; however, there is an evident lack of rigour in the issue of safety certificates and in the subsequent inspections required over the full working life of fishing vessels. The instruments of control are at a similar low level of enforcement, for the Memoranda of Understanding ruling in Europe, Asia and South America (the Agreements of Paris, Tokyo and Viña del Mar) are not applicable. The reality of this situation has been denounced by the employers and employees acting collectively, through the International Shipping Federation (ISF) and the International Transport Federation (ITF)[2].

At the regional level certain initiatives have taken place, particularly in the European Union; however, their real effect continues to be limited by the reduced segment of the fleet to which the standards are applicable: the European Directive 97/70/EC is for ships of more than 24 m, and Directive 93/103/EC is for ships of fifteen to eighteen metres; only 3% of the European fishing fleet exceeds 24 m, so this leaves a big gap that we have to narrow (EU, 1993, 1997).

[2] 40th Conference of the International Transport Federation (ITF) held in Vancouver from 14 to 21 August 2002.

The risks and the corresponding prevention policies in matters of safety and occupational health are consequently very different between the vessels of these two segments; therefore, the relative lack of regulation in the more numerous artisanal and shallow-water fishing fleet requires efforts that have not yet been achieved, of the same scale as those the IMO has been making for the merchant fleet. There is not even uniformity in the countries of the European Union, neither in the standards required of the safety devices nor even in the ways of reporting accidents, that might serve as the basis for research on the prevention of hazardous situations (Pérez-Labajos, 2008).

### *1.3. Systems for the management of safety on board vessels*

Normally when we speak of an advanced society, in this case of a sector of the society that aspires to welfare, we would think of an indicator of quality such as the prevention of losses by accidents. The more mature a country is, the greater should be its capacity for implementing policies for the prevention of harmful circumstances, particularly in the significant areas of activity such as work. Taking preventive measures is nothing more than executing measures to ensure reliability in the context of work systems. The implementation of systems of prevention based on recognising the possibility of human error (PTP, Prevention Through People) involves establishing systems with stipulated procedures and instructions so that activities are carried out safely, as part of the organisation of the work. Managing an activity, of whatever kind, means establishing the processes by which it should be performed. Since the end of the 20th century, industry has been open to the adoption of systems for the management of quality, for environmental management, for safety management, and more recently, to systems for the integrated management of all these important aspects. Similarly, voluntary standards have been incorporated that have improved quality in the design of products and in the provision of services.

In short, there has been a generalised acceptance of the need for a system of procedures (in which we describe how things are to be done), of documentation (in which we confirm and record that things have been done in accordance with the procedures, as proof of this), of auditing (whereby we check whether things have been done as they should), and of continuous improvement (whereby

**Table 1**
Chart of assessment of the risk

| | | Consequences | | |
|---|---|---|---|---|
| | | Light L | Severe S | Serious G |
| Probability | Low B | Trivial risk T | Tolerable risk TO | Moderate risk MO |
| | Medium M | Tolerable risk TO | Moderate risk MO | Significant risk I |
| | High A | Moderate risk MO | Significant risk I | Intolerable risk IN |

| Risk | Action and timing |
|---|---|
| Trivial (T) | No specific action required. Check periodically that the risk stays trivial. |
| Tolerable (TO) | The existing preventive action does not need improving. However more cost-effective solutions should be considered, or improvements that do not represent significant extra cost. Periodical checks are required to ensure that the effectiveness of the control measures already in place is maintained. |
| Moderate (M) | Efforts should be made to reduce the risk, by adopting additional preventive measures, and determining the investments required. The measures for reducing the risk should be implemented in a specified period. When the moderate risk is associated with extremely harmful potential consequences, further action is essential to establish with greater accuracy the probability of damage as a basis for determining whether the control measures need to be improved. |
| Significant (I) | The work associated with this risk should not be commenced until the risk has been reduced. Considerable resources may be required to control the risk. The measures for reducing the risk should be implemented as a priority, sooner that those for the moderate risks. |
| Intolerable (IN) | The work associated with this risk must not be commenced or continued until the risk has been reduced. If it is not possible to reduce the risk, even with unlimited resources, the work must be prohibited. The measures for reducing the risk should be implemented immediately |

we apply corrective and preventive measures for identified faults, errors and shortfalls).

If the maritime sector is suffering an accident rate much higher, in proportion, than other on-land occupational sectors, this is clearly due to the absence of an adequate capacity of control, but also due to other reasons: the much more aggressive nature of the working environment and methods, especially in respect of the environmental conditions, and to the fact that the activity takes place at sea (Sánchez-Trigueros, 2004); the mechanisms involved in the occurrence of accidents and the social-economical factors. Morel and Chavin (2006) have shown that the French sea fishing system is exposed to very high constraint; under the effect of these constraints, the sea fishing system is "pushed" towards the safety limits. This migration towards the safety limits allows the fishermen to increase their remuneration.

In order to improve the safety systems we must take those measures – decisions and actions – that would limit or at least make

less likely the occurrence of situations that lead to accidents, whether passively or actively.

Normally when prevention is considered in the context of activities on board vessels, the physical implementation of preventive measures is always associated first with hardware, with life-saving and safety devices for the boat, its equipment and its crew members; secondary measures involve software, the logical implementation of prevention in the form of a series of codes of behaviour, signs, instructions, posters; and only in recent years has a third approach to prevention received much attention, which is the organizational ("orgware") implementation particularly by means of a Code of Management for the Safety of the Vessel (ISM), and hence of a System of Management that involves the coordination, communication and the specific organisation of all the components of the working systems that are operated on a vessel, and at the interface of the vessel with the port, in its operations of loading and unloading (Chen, 2000).

From the 1980s onwards, serious concern for weakness in these standards of management has begun to move the shipping industry, particularly as a result of a series of very bad accidents, the more significant being the sinking of the "Herald of Free Enterprise" (in March 1987) and the disaster of the "Scandinavian Star" (in April 1990) (Hamblen and Edey, 1999; Clarkson, 1996). In December 1988, the United Kingdom put into effect, for ferry ships, certain stricter standards which included the designation of a person onshore responsible for coordination with the vessel. In 1989, the IMO adopted the first management guidelines for the safe operation of vessels and for the prevention of contamination. In May 1991, it was the Nordic countries that began to speak of policies for the management of quality and safety, based on the standards already established onshore, such as the ISO 9000 family of standards, and proposed an obligatory system of safety management for passenger vessels and other vessels of more than 5000 GT. In 1993, the IMO revised those guidelines and recommended the implementation of a code of management, the International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM), made mandatory by its formal attachment to Chapter IX of SOLAS, as amended in 1994 (IMO, 1993b). ISM involves a system of management based on the requirements of the ISO standard that is a model for the assurance of quality in production, installation and service. By means of a schedule of implementation, today all SOLAS vessels, that is, all those of gross tonnage equal to or more than 500 GT on international voyages, should have a system of safety management that meets the objectives and the inspections stipulated in the ISM Code (Brooks, 2005; Kaplan and Kite-Powell, 2000).

## 2. The organisation of work on fishing vessels

As we have seen, in the socio-occupational field, maritime fishing activity presents peculiarities that clearly distinguish it from other sectors or branches of economic activity. The specificity of fishing work is determined by diverse historical factors and circumstances, such as the intrinsic isolation, meteorological factors and other external factors in general, the intermittent nature of fishing extractive activity which makes planning of the activity impossible, the arduous working conditions in themselves, and the difficulties from being subjected to a strict regime of working day and rest periods (Sánchez-Trigueros, 2004; Horck, 2004).

In turn, the initial difficulty clashes with the need to plan the work and to have a minimum degree of organisation for safe working on board. Good organisation is a key element for successfully integrating the preventive activity and management of the prevention of occupational risks in any company. Organisation is important not only for the business management but also for the occupational situation of each person in respect of their health and their opportunities for contributing effectively to the work. It contributes to increasing productivity in the job, to maintaining the health and the personal development of the individual, and includes everything related to methods and times, and to communications. Control public policies must support and encourage a "change of course" in the fishing safety situation in order to improve the actual organisation system, on the contrary there will not be available forces to get better in a system influenced by economical aspects.

The organisation of work on the fishing vessels is critically important[3], and poor organisation is considered to be one of the most important causes of the accidents that happen (Törner and Eklof, 2000; Törner and Nordling, 2000; Jensen et al., 2006). The way in which the work is organised is a determining factor that has a direct influence on the causality of accidents.

On fishing vessels the particular characteristics under which the employees carry out their work activity are:

- There are important conditions of safety that are not required in other centres of work, such as floatability, water-tightness and stability of the workplace.
- Crew members are subject to instability while they work due to the continuous rolling and pitching movement of the boat.
- Prolongation of the working day, which means that employees are exposed to the occupational risks for longer periods of time.
- Cramped and restrictive areas and volumes of the physical working space, in which there are numerous potentially hazardous objects: nets, wires, ropes, winches, remains of fish, etc., all on wet, slippery surfaces.
- Direct exposure to the weather and the sea.
- Isolation.
- Shift work.
- Night work.

As can be observed, most of these factors can have severe psychosocial effects, which are likely to be aggravated by others, such as the system of remuneration[4].

The regulations applicable, in the case of Spain, to the prevention of occupational risks (Spanish Law for the Prevention of Occupational Risks 31/1995) in any of the industrial sectors, present serious difficulties for their effective implementation on fishing vessels. In a statistical study conducted by FACOPE, the "Federación Andaluza de Cofradías de Pescadores" (Andalusian Federation of Fishermen's Guilds) to check the implementation of the prevention of occupational risks in the fisheries sector of Andalusia, the following results were obtained: the survey was conducted at thirteen fishing ports in the relevant provinces of Andalusia: Malaga, Almería, Cádiz, Granada and Huelva; of a total of 649 companies surveyed, only 60 (9.24%) undertook any planning of the preventive activity on their boats by contracting an Independent Prevention Service. These data show the relative lack of implementation of preventive measures against occupational risks in the sector.

Despite the fact that the Law for the Prevention of Occupational Risks came into force in the year 1995, and as such has been obligatory for the companies to comply with since then, in the fisheries sector its requirements were largely unknown until only a few years ago. There are several relevant arguments that make fishing

[3] A description of the work that is done aboard the fishing vessels and the type of different risks has been highlighted by a previous study (Piniella et al., 2008)

[4] The "salary" of the workers takes the form of a proportional share (in spanish "salario a la parte"), in function of the job position held, and the profits obtained from the catch. This system permits all the crew to obtain a benefit from their work, but can be a risk factor that encourages fishermen to accept unsafe working conditions and prolonged working days.

**Table 2**
Example of initial check-list: fishing work

| Criteria to be assessed | NA | YES | NO |
|---|---|---|---|
| 1. Is adequate maintenance of the tackle is carried out? | | | |
| 2. Are plastic containers employed? | | | |
| 3. Do the control levers of the winching gear have displayed the commands: haul in, stop, pay out? | | | |
| 4. Is the winching gear equipped with an automatic system that prevents overloading, and is the system operative? | | | |
| 5. In the case of double controls (local and remote) for actuating the winching gear, is it equipped with the means of preventing both the controls being actuated simultaneously? | | | |
| 6. Are the components of the winching gear (cables and brakes) in good condition? | | | |
| 7. How frequently do breakdowns occur in the winching gear? | | | |
| 8. TRAWLING: Are automatic guides utilised for the catch? | | | |
| 9. TRAWLING: Do all the moving parts of the winches and chain guides have protective devices? | | | |
| 10. TRAWLING OR SEINING: Do the guide blocks have safety catches? | | | |
| 11. SEINE NET: Is water pumped before sending the fish to the hold? | | | |
| 12. SEINE NET: Do you recall any operation in which the stability of the boat was endangered by an excess of fish in the net? | | | |
| 13. SEINE NET: Is there a dynamometer on the suspension hook? | | | |
| 14. LONGLINE: On the longline/boulter, are the baskets, buckets, and line reels fastened so as not to tip over in bad weather? | | | |
| 15. LONGLINE: Are gloves worn when baiting the hooks or when handling the longlines? | | | |

**Table 3**
Example of initial check-list: safety equipment

| Criteria to be assessed | NA | YES | NO |
|---|---|---|---|
| 1. The number of life-rafts on board, their capacity and identification in conformity with the legislation | | | |
| 2. They are stowed correctly for launching in the event of an emergency | | | |
| 3. The raft and the hydrostatic release mechanism are in good condition | | | |
| 4. They carry instructions for paying out | | | |
| 5. There is illumination in the place where they are stowed | | | |
| 6. A crew member is present during the inspection of the raft | | | |
| 7. Do the life belts comply with the regulations? | | | |
| 8. Does the number of life belts comply with the regulations? | | | |
| 9. Are the life belts correctly distributed on board? | | | |
| 10. Are the life belts easily released from their stowage points? | | | |
| 11. Do the life jackets comply with the regulations? | | | |
| 12. Are the life jackets worn during the fishing activities? | | | |
| 13. On the auxiliary boats for seine net fishing, do the crew members wear life jackets? | | | |
| 14. Are the life jackets kept in the zones required according to the legislation? | | | |
| 15. Are the life jackets properly stored, and are the closing and fastening devices in perfect condition? | | | |
| 16. Are the instructions on how to put on the life jacket clearly displayed? | | | |
| 17. Do the pyrotechnical signals comply with the legislation? | | | |
| 18. Are the pyrotechnical signals correctly stowed? | | | |
| 19. Are the pyrotechnical signals in perfect condition for immediate use? | | | |
| 20. Are safety gloves worn? | | | |
| 21. Are safety boots worn? | | | |
| 22. Is waterproof clothing worn? | | | |
| 23. Is the waterproof clothing of visible colour? | | | |
| 24. Are protective goggles worn when selecting the fish? | | | |

**Table 4**
Example of initial check-list: fire prevention and fire-fighting

| Criteria to be assessed | NA | YES | NO |
|---|---|---|---|
| 1. Do all the crew members know where the items of fire-fighting equipment are located? | | | |
| 2. Have the portable fire extinguishers been checked in the last year? | | | |
| 3. Are the fire extinguishers located in the correct places? | | | |
| 4. Does the vessel carry the correct number of extinguishers on board, with the correct capacity and composition for the characteristics of the vessel? | | | |
| 5. Does the vessel have a dedicated fire-fighting pump? | | | |
| 6. Does the fire-fighting pump function correctly? | | | |
| 7. Does the vessel have automatic fire detection and extinguishing systems? | | | |
| 8. Does the vessel have automatic closing of ventilation ducts in the event of fire? | | | |
| 9. Does the ventilation closing system function correctly? | | | |
| 10. Does the vessel have sufficient buckets? | | | |
| 11. Does the vessel carry a fire-fighting hose on board? | | | |
| 12. Does the fire-fighting hose reach all the vulnerable parts of the vessel? | | | |
| 13. Are the hoses and connectors in good condition and are they stowed correctly for their utilisation? | | | |
| 14. Can the fire-fighting pump be operated independently of the principal engine? | | | |
| 15. Is there a connection to land on board with all its correct flange elements? | | | |
| 16. Does the vessel have fixed fire-fighting installations? | | | |
| 17. Is the engine/machinery room in optimum conditions of order and cleanliness? | | | |

**Table 5**
Example of initial check-list: safety on board

| Criteria to be assessed | NA | YES | NO |
|---|---|---|---|
| 1. The interior spaces of the boat have access to fresh air | | | |
| 2. There is mechanical ventilation or air conditioning, and it functions adequately | | | |
| 3. The conditions of the interior spaces generate situations of extreme temperature | | | |
| 4. The crew accommodation is comfortable in respect of space, illumination, cleanliness, etc. | | | |
| 5. The vessel has watertight doors | | | |
| 6. The watertight seal or gasket is in good condition | | | |
| 7. The hinged watertight doors close from both sides | | | |
| 8. There is a warning on both sides that they must be closed while under way | | | |
| 9. The deck of the vessel and the interior spaces have anti-slip flooring | | | |
| 10. The deck has ribs, slopes or changes of level | | | |
| 11. There is emergency lighting in the interior zones of the vessel, and it functions correctly | | | |
| 12. The passages and walkways are fitted with handrails | | | |
| 13. The hatches or thwarts are fitted with coaming or seaguards | | | |
| 14. The crew can move without obstruction in their working areas | | | |

**Table 6**
Example of initial check-list: safety records

| Criteria to be assessed | NA | YES | NO |
|---|---|---|---|
| 1. Is a daily fishing log kept? | | | |
| 2. Does the positioning equipment function correctly? | | | |
| 3. Is the functioning of the positioning equipment checked periodically? | | | |
| 4. Are nautical charts available? | | | |
| 5. Is the vessel fitted with navigation lights? | | | |
| 6. Is the functioning of the navigation lights checked periodically? | | | |
| 7. Can the engine controls be operated from the bridge? | | | |
| 8. Is the vessel equipped with ground tackle? | | | |
| 9. Does the ground tackle function correctly? | | | |
| 10. Does the vessel have winching gear to raise the ground tackle? | | | |
| 11. Does the engine function correctly? | | | |
| 12. Is the engine in good condition? | | | |
| 13. Does the engine have oil pressure indicators? | | | |
| 14. Do the engine oil pressure indicators function correctly? | | | |
| 15. Does the engine have rpm indicators? | | | |
| 16. Do the engine rpm indicators function correctly? | | | |
| 17. Does the engine have temperature indicators? | | | |
| 18. Do the engine temperature indicators function correctly? | | | |
| 19. Does the engine have an oil pressure alarm? | | | |
| 20. Does the oil pressure alarm function correctly? | | | |
| 21. Does the engine have an rpm alarm? | | | |
| 22. Does the rpm alarm function correctly? | | | |
| 23. Does the engine have a temperature alarm? | | | |
| 24. Does the temperature alarm function correctly? | | | |
| 25. Does the engine have an oil change pump? | | | |
| 26. Is the sea valve accessible? | | | |
| 27. Does the vessel have a bilge pump? | | | |
| 28. Does the bilge pump function correctly? | | | |
| 29. Does this pump have a suction filter? | | | |
| 30. Does the pump detect automatically when it must operate? | | | |
| 31. Is the bilge discharge point above of the waterline? | | | |
| 32. Is a boat hook available? | | | |
| 33. Are there alarms that warn of the entry of water? | | | |
| 34. Is the hold divided into sections? | | | |

activity one of the activities of primordial importance in respect of taking active measures to prevent occupational risks and improve health and safety conditions for the employees who carry out such activity.

In the studies conducted by our research group in previous years, some of these dysfunctions in matters of safety were detected. Given the family structure reflected in the composition of the crews (Piniella et al., 2007), the policies of the National and Regional governments aimed at the modernisation of the fishing fleet, as in the case studied of the Regional Government of Andalusia and its Plan for the Modernisation of the fisheries sector of Andalusia, have had a slight impact on the trends in the rate of accidents, but would serve for nothing if there is no change in the organisation of the work. It is true that the mean age of the fleet, at least, has been reduced (and in the case studied, this has dropped from the 29 years that was reflected in the plan in 1997 to the 20 years revealed in our study); and this current mean age of the fleet at least coincides with the limit established by the European Parlia-

**Table 7**
Classification of risks

| | |
|---|---|
| 01. | *Falls of persons to a lower level*: Includes both falls from heights (from buildings, trees, machinery, vehicles, etc.), and into depths (into excavations, down stairs, into holes in the ground, etc.) and falls into water |
| 02. | *Falls of persons at the same level*: Includes falls on walkways or working areas, and falls on or against objects |
| 03. | *Injuries from falling objects dislodged by deterioration or demolition*activity: Includes the possibility of objects falling due to the instability of particular fixed structures of plants, bridges or buildings |
| 04. | *Injuries from falling objects dropped while being handled*: Includes tools, materials, etc., falling on a worker, provided the injured person is the one from whom the object being handled falls (i.e. self-injury) |
| 05. | *Injuries from loose falling objects*: Includes tools, materials, etc., falling on a worker, provided it is not that worker who is handling the object. It includes objects falling due to the instability of the vessel, which is increased when sea conditions are bad |
| 06. | *Tripping over objects*: Includes the accidents that give rise to injuries as a consequence of tripping over objects abandoned on the ground, or over irregularities, without actually causing the employee to fall down |
| 07. | *Impacts and knocks against static objects*: Includes the impact against objects that are fixed or in position of rest. Examples: bulkheads, doors, furniture, etc |
| 08. | *Impacts and contacts against moving objects*: Includes impacts, cuts, scratches, etc., caused by moving parts of machinery and installations. Being trapped in equipment is not included here |
| 09. | *Impacts and cuts from objects or tools*: Includes the possibility of injuries from interactions with sharp cutting, pointed or abrasive objects, manual and mechanical tools, utensils and devices, etc |
| 10. | *Ejection of fragments or particles*: Includes the ejection, towards the worker, of particles or fragments originating from machinery or tools, and the projection of liquids, flakes or other similar materials |
| 11. | *Entrapments by or between machinery and objects*: Includes a part of the body being trapped between objects or within the mechanisms of machines |
| 12. | *Entrapments due to machines or vehicles overturning: Includes the entrapments due to a tractor, vehicle or other machine overturning, leaving the worker trapped by it* |
| 13. | *Over-exertions*: Includes the handling of loads, badly-executed movements, and forced postures |
| 14. | *Thermal contacts*: Includes the contact of any part of the body with objects submitted to extreme temperatures (including liquids and solids) |
| 15. | *Direct electrical contacts*: Includes direct contact with any live part. Electricity power lines, of high and low voltage, generators, transformers, inputs to switchboards, etc. |
| 16. | *Indirect electrical contacts*: Includes electrical contact with earthing or ground wires accidentally connected to a voltage. Defective cables, plugs and sockets in bad condition, shunts in machines, bare terminals, distribution boards, electric motors, etc |
| 17. | *Explosions*: Includes the actions that give rise to injuries caused by the shock wave and its secondary effects |
| 18. | *Fires*: Includes the actions produced by the effects of fire and its consequences |
| 19. | *Accidents caused by living beings*: These include accidents caused directly by animals, whether attacks, bites, stings, etc |
| 20. | *Accidents caused by impact from vehicles*: These include the possibility of suffering an accident due to being hit or knocked down by a motorised vehicle, including private vehicles, trucks, vans, etc |
| 21. | *Exposure to physical agents: Includes the possibility of being submitted continuously to levels of noise higher than those permitted by the ruling legislation, vibrations of high, medium or low frequency originating from machinery and/or vehicles, ionising or non-ionising radiation, deficient levels of illumination, thermo-hygrometric conditions* |
| 22. | *Exposure to chemical agents*: Includes contact by the employee with a chemical agent present at the place of work |
| 23. | *Exposure to biological agents*: Includes contact with microorganisms, including those genetically modified, cellular cultures and human endoparasites, liable to produce any kind of infection, allergy or toxicity |
| 24. | *Ergonomic factors: Includes the possible harm from having to work in environments with deficient or inadequate level of illumination, temperature, noises, air quality, etc. Examples: Flashing lights, reflections, glare, lack of definition of details, due to deficient illumination, excessive heat, etc* |
| 25. | *Psychosocial factors*: Includes factors directly related to the organisation, the content of the work and the performance of the task, and which have the capacity to affect not only the physical health but also the psychological and social health of the employee, and the normal performance of the work |
| 26. | *Screens for the visualisation of data: Includes the risk factors associated with working with data visualisation screens* |
| 27. | *Other factors*: Any other hazard not described in the preceding parts |

ment. Both the factors should be taken into account in putting forward policies aimed at regulating the fishing sector of Andalusia: safe infrastructures and procedures for checking these, and proper organisation of the work on board.

## 3. Material and application

### 3.1. Initial proposal of check-lists

Having justified the need for a minimum level of organisation and safety management on board fishing vessels, we now present the first proposal of those that we believe are required in accordance with the objectives of our project on the safety of the artisanal fishing fleet: the production of check-lists, which can be considered a proposal for a procedural improvement. These initial check-lists were prepared on the basis of the conclusions reached in our research project surveying some 250 boats; the methodology of this study has been published in the previous paper (Piniella et al., 2008). The objective was to feature the safety "black spots" detected in our field research, as a basis for the production of check-lists that were subsequently institutionally ratified by their application by the Regional Government through its policies for the inspection of safety on board fishing vessels. These check-lists can be considered specific and efficacious working instruments that are capable of detecting the various risks faced, thus allowing corrective measures to be taken. They cover a series of questions referring to the standards in navigation, equipment and training that should exist to ensure a correct monitoring of the possible risks. The following Tables 2–6 are presented as examples of these check-lists. Each questionnaire also obtained, in its heading, the identification data, adapted to the different topics surveyed, and their involvement in the subsequent assessments (age, type of fishing, fishing port, length of the boat,...) and the date. The questionnaires offered respondents three response options. The response selected, affirmative (YES), negative (NO) or not applicable (NA), would be marked with a cross in the corresponding box of the adjacent column. In the lower part of the assessment chart, a space, which could be amplified if necessary, was reserved for noting the actions that had been taken to correct the deficiencies detected. The corrective measures should be stated indicating the priority given to the deficiency in question, classified as either unacceptable, very deficient, deficient or improvable, with the time of execution being indicated in the corresponding part. It has also been thought appropriate to include, as complementary data, the criteria of assessment of the

evaluating team. However, this methodology is not closed, so the user has the option of varying the criteria of assessment and of incorporating new questions if considered necessary. In making modifications, the intention is that the questionnaire should be as clear and concise as possible, so that it can be applied by persons without specialised training in the prevention of risks. The check-lists were prepared taking into account the ruling regulations in respect of maritime safety and the prevention of occupational risks; it would be a fundamental objective in the implementation of a system of management in fishing vessels to get the legislation referring to both the fields applied by consensus, rather than by imposition[5].

### 3.2. Practical application of the check-lists

From an institutional perspective, check-lists are a basic instrument in performing evaluations of occupational risks. The occupational risks Prevention Service of the "Empresa Publica de Desarrollo Agrario y Pesquero", part of the Regional Government of Andalusia, produced a series of templates to assist in the study and development of these evaluations based on the previous research work done in our SEGUMAR project. The methodology employed in the assessment of these risks was based on Article 3 of the Royal Decree 39/1997, of 17 January, which approved the regulation of risk prevention services: *"the assessment of risks is the process directed towards estimating the magnitude of those risks that may be impossible to avoid, obtaining the information necessary so that the businessman or entrepreneur may be equipped to take an appropriate decision on the need to adopt preventive measures, and, in that case, on the type of measures that should be adopted*".The procedure for performing the risk assessment is divided into two phases, a first stage of identification of risks, and a second stage of assessment (see Table 7).

#### 3.2.1. Analysis of risks

In the identification of hazards, these are understood as any source or situation with the capacity to produce a particular type of harm or damage. The consequences of hazards can be personal injuries, damage to properties or installations, damage to the natural environment, or a combination of any of these. In this phase, therefore, the aim is to detect all those factors or elements of the work that constitute direct or indirect sources of danger. For the identification of the risk, attention will be paid to the consequences that the risk may provoke; that is, to the ways in which the victim or entity damaged interacts with the causal factor. The method utilised is the direct appreciation of the risk, supported by any information that may be useful, such as:

- Definition and description of functions and tasks carried out by the personnel.
- Statistics of occupational accident types and rates of occurrence.
- Direct observation of the operations performed by the workers in their places of work, on the vessels in port and at sea.
- Information on the periodic health inspections carried out on the workers.

The information that may be useful for the production of the evaluations would be collected by means of surveys using specific questionnaires for each type of job.

The classification of the risks adopted by the Company is that presented in Table 10.

#### 3.2.2. Estimation of harm or damage

1. – Consequences of the harm or damage
   To determine the potential severity of the consequences, the parts of the body that may be affected and the intrinsic nature of the injury or harm are taken into account; damage can thus be rated as:
   *L Light*: This would cover superficial injuries such as cuts and minor knocks, irritation of the eyes by dust and water, exposure to the sun, irritation and pains, headaches, and discomfort, etc.
   *S Severe*: This covers lacerations, burns, concussions, significant strains and sprains, minor fractures, dermatitis, asthma, muscular–skeletal disorders, disease that leads to a minor disability, etc.
   *G Serious*: These include amputations, larger fractures, intoxications, multiple injuries, fatal injuries, cancer and other chronic diseases that significantly shorten life.
2. – Probability of occurrence of the damage/harm
   The probability of occurrence is graduated in accordance with the following criteria:
   *A High*: The damage always or almost always occurs.
   *M Medium*: The damage occurs on some occasions.
   *B Low*: The damage rarely occurs.

#### 3.2.3. Assessment of the risk

For the assessment of the risk, the method to be followed is based on a chart (Table 1), in which the abscissa axis indicates the consequence, and the ordinate axis the probability. When the result of the Risk Assessment study demonstrates situations of risk for the health of the employees, the preventive measures necessary to eliminate or control and reduce these risks should be included in the Risk Assessment study. The attached templates, the final phase

[5] The Spanish legislation with respect to the prevention of occupational risks is included in the R.D. 1216/1997, of 18 July, which establishes the minimum health and safety provisions for work on board fishing vessels. Despite the fact that this decree excludes boats of less than 15 m and 18 m length (and hence is not applicable to most of the boats recorded in the census of the fishing fleet, as commented previously), its content is relevant for the production of check-lists and the assessment of risks in fishing boats, since the following aspects are dealt with:
- It states the obligations of the ship owner regarding the measures to be adopted in respect of the equipment and its maintenance, information and training of the employees, specialised training, and the consultation and participation of the employees.
- It covers the minimum health and safety provisions applicable to new and existing fishing vessels, to their life-saving and survival gear, and to the individual protective gear.
- It contains regulations referring to navigability and stability, mechanical and electrical installations, crew accommodation, ventilation, first aid, etc.
- Other laws referring to the prevention of occupational risks that should be considered in the performance of risk evaluations are the following:
- Law 31/1995, of 8 November, for the Prevention of Occupational Risks.
- Law 54/2003, of 12 December, for the reform of the regulatory framework for the prevention of occupational risks.
- Royal Decree 1995/1978, of 12 May, which approved the definitions of occupational diseases covered by the social security system.
- Royal Decree 39/1997, of 17 February, by which the Regulation of Prevention Services was approved.
- Royal Decree 485/1997, of 14 April, on the minimum provisions in questions of the warning signs and notices for safety and health at work.
- Royal Decree 487/1997, of 14 April, on the minimum provisions for health and safety in respect of the manual handling of cargos that involve risk.
- Royal Decree 664/1997, of 12 May, on the protection of employees against the risks related to exposure to biological agents at work.
- Royal Decree 773/1997, of 30 May, on the minimum provisions for health and safety in respect of the utilisation by employees of personal protective gear.
- Royal Decree 1215/1997, of 18 July, on the minimum provisions for health and safety in respect of the utilisation by employees of personal protective gear.
- Royal Decree 374/2001, of 6 April, on the protection of the health and safety of employees against the risks related to chemical agents at work
- Royal Decree 614/2001, of 8 June, on the minimum provisions for the protection of the health and safety of employees against electrical risks.
- Royal Decree 286/2006, of 10 March, on the protection of the health and safety of employees against the risks related to exposure to noise at work.

**Table 8**
Example of list employed in the practice of risk assessment: Risks on deck

| Empresa Pública Desarrollo Agrario y Pesquero CONSEJERÍA DE AGRICULTURA Y PESCA | ASSESSMENT OF RISKS | FILE: REV: |
|---|---|---|
| **TASKS / SECTIONS: DECK** | | DATE: |

| | Risk code | Consequence | | | Probability | | | Assessment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **L** | **S** | **G** | **B** | **M** | **A** | **T** | **TO** | **M** | **I** | **IN** |
| 01 | Falls of persons to a lower level | | | | | | | | | | | |
| 01 | Falls of persons to a lower level (falls into the sea). | | | | | | | | | | | |
| 02 | Falls of persons at the same level | | | | | | | | | | | |
| 04 | Injuries from falling objects dropped while being handled | | | | | | | | | | | |
| 06 | Injuries from tripping over objects | | | | | | | | | | | |
| 07 | Impacts and knocks against static objects | | | | | | | | | | | |
| 08 | Impacts and contacts against moving objects | | | | | | | | | | | |
| 09 | Impacts, cuts and punctures from objects or tools | | | | | | | | | | | |
| 11 | Entrapment by or between machinery and objects | | | | | | | | | | | |
| 13 | Overexertions | | | | | | | | | | | |
| 19 | Accidents caused by living beings | | | | | | | | | | | |
| 21 | Exposure to physical agents | | | | | | | | | | | |

| Consequence | Probability | Assessment |
|---|---|---|
| L Light G Serious<br>S Severe | B Low A High<br>M Medium | T Trivial I Important<br>TO Tolerable IN Intolerable<br>M Moderate |

**Preventive measures**
The deck will be kept clean of grease and oil, and the anti-slip coating will be renewed periodically. There will be warning si gns on those parts of the structure, transit and working zones that protrude and against which people may easily knock and injure themselves. The accesses to valves, switches of electrical handling equipment, firefighting elements, first aid materials, etc. will be kept clear. All ele ments that may move will be kept well lashed down, and the ropes well coiled. Puddles and accumulations of water will be prevented, and the scuppers will be kept unobstructed. Handrails and grips will be employed where necessary.

| Personal protective gear | Measures for collective protection |
|---|---|
| Safety harness and belt<br>Woollen gloves<br>Latex gloves, EN 374-3<br>Leather gloves, EN 388<br>Non-slip work boots EN 347<br>Head Cap<br>Inflatable life jacket, worn during fishing activities and in bad weather. EN 396 | Use of sun cream when sun's rays are intense. |

**Assessment criteria:**
Law 31/1995, of 8 November, for the Prevention of Occupational Risks.
Royal Decree 1216/97 on minimum provisions for health and safety on board fishing vessels.
Royal Decree 773/1997, of 30 May, on the minimum provisions for health and safety in respect of the utilisation by employees of personal protective gear.
Royal Decree 1215/1997 of 18 July. Ruling on work teams.
Technical criteria.

of our research study, cover the assessment of risk, preventive measures, use of collective and individual protective measures, and criteria of assessment. These templates (Tables 8–10) are of general character and do not refer to any particular vessel; they relate to various different sections of the vessel and to emergency measures.

## 4. Conclusions

The establishment of a safety management system is an indispensable tool for preventing risks of accidents at work due to installations and equipment; today such an affirmation would be perfectly understood and applicable in nearly all occupational sectors but in the sector studied, the fishing industry, it appears particularly difficult to achieve: high risk of loss of life or injury has been accepted as a part of the fishing-culture, of a social model of "fatalism".

We believe strongly that procedures should be established by which periodic examinations are conducted of the hazardous conditions actually or potentially presented by the techniques of fishing, with all the various kinds of equipment and installations utilised, by their design, functioning or situation within the context of work activities, as we have already proposed in previous work. The safety devices and systems that are useful when faced with the need to act on foreseen faults or emergency situations should

**Table 9**
Example of list employed in the practice of risk assessment: the Bridge

| Empresa Pública Desarrollo Agrario y Pesquero CONSEJERÍA DE AGRICULTURA Y PESCA | ASSESSMENT OF RISKS | FILE: REV: |
|---|---|---|
| **TASKS / SECTIONS: BRIDGE** | | DATE: |

| | Risk code | Consequence | | | Probability | | | Assessment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | S | G | B | M | A | T | TO | M | I | IN |
| 02 | Falls of persons at the same level (slipping) | | | | | | | | | | | |
| 21 | Exposure to physical agents (noise) | | | | | | | | | | | |
| 21 | Exposure to physical agents (non-ionising radiation). | | | | | | | | | | | |
| 24 | Ergonomic factors. | | | | | | | | | | | |

| Consequence | | | | Probability | | | | Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| L | Light | G | Serious | B | Low | A | High | T | Trivial | I | Important |
| S | Severe | | | M | Medium | | | TO | Tolerable | IN | Intolerable |
| | | | | | | | | M | Moderate | | |

**Preventive measures**
Provide correct illumination (of navigation, positioning and radio communications equipment) to prevent damage to vision (21)
Keep apertures open to ensure adequate ventilation (24)
Keep radiofrequency-emitting equipment switched off and disconnected from the electricity system while not being used.
Safety Manual for operations with risk of exposure to radio frequencies (21)
While under way keep the doors of the bridge closed to avoid excessive noise (21)
If there is sufficient space, provide an ergonomic seat correctly fixed to the floor, to prevent slips and falls. (01, 24)

| Personal protective gear | Measures for collective protection |
|---|---|
| Non-slip work boots EN 347 | Use of sun cream when sun's rays are intense. |

**Assessment criteria:**
Law 31/1995, of 8 November, for the Prevention of Occupational Risks.
Safety Manual for operations with risk of exposure to radio frequencies. (Polytechnic University of Valencia).
Technical criteria.

be kept in optimum conditions of operation, ensuring their efficacy and performance during their useful life, and thus reducing the possibility that they may fail or break down because of their poor condition.

Our study has allowed us to make an extensive analysis of the fishing sector in the geographic region of Andalusia, in the south-west of Spain; it has enabled us to analyse in fine detail the specific risks of each technique (Piniella et al., 2008), and to determine the key elements involved in the assessment of safety by means of check-lists.

In Andalusia artisanal fishing is the predominant type; here the length segment of the fleet ranges from 4 to 26 m, with 99% of the boats being less than 24 m length, which means that almost all the boats fall outside the applicability of the Torremolinos agreement; there is also a notable scarcity of legislation that would regulate the sector, leaving the matter of occupational risks to be covered under the complementary standards of the SOLAS and other general regulations. For these reasons, and with the object improving this situation, the compilation in a single document of all the existing legislation applicable to the fishing fleet of Andalusia would be of great value. Such a document should be made readily available to ship owners and seamen in general so that they have a better knowledge of the legal framework that regulates the state of the boats. An International Code of safety management for fishing vessels also needs to be established, which includes at least the items proposed in the check lists presented in this article. The experience of the ISM Code in merchant vessels presents an opportunity for the application of something similar in another sector of maritime work that may be of a smaller dimension physically but is surely of a larger dimension in human terms, given its social and economic profile and the high rate of accidents suffered in the sector. In the meantime we can be satisfied that the results of our project allow the regional Government of Andalusian to take action, in respect of the region's fishing sector, on the prevention of occupational risks in a more systematic and procedural way by means of check-lists such as those we present, by way of example, in the various Tables attached to this article. However, the organisational aspects are linked to the economical aspects in a very productive system, only a new safety-culture, sufficiently developed with a public policy of control of the vessels and the crews, will allow to speed up the changes in safety management and the use of tools similar to those studied in this paper.

**Table 10**
Example of list employed in the practice of risk assessment: the Engine Room

| Empresa Pública Desarrollo Agrario y Pesquero CONSEJERÍA DE AGRICULTURA Y PESCA | ASSESSMENT OF RISKS | FILE: REV: |
|---|---|---|
| **TASKS / SECTIONS: ENGINE ROOM** | | DATE: |

| | Risk code | Consequence | | | Probability | | | Assessment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | S | G | B | M | A | T | TO | M | I | IN |
| 01 | Falls of persons to a lower level | | | | | | | | | | | |
| 02 | Falls of persons at the same level | | | | | | | | | | | |
| 04 | Falls injuries from falling objects dropped while being handled | | | | | | | | | | | |
| 07 | Impacts and knocks against static objects | | | | | | | | | | | |
| 09 | Impacts, cuts and punctures from objects or tools | | | | | | | | | | | |
| 10 | Ejection of fragments or particles | | | | | | | | | | | |
| 11 | Entrapment by or between machinery and objects. | | | | | | | | | | | |
| 14 | Thermal contacts | | | | | | | | | | | |
| 15 | Direct electrical contacts | | | | | | | | | | | |
| 16 | Indirect electrical contacts | | | | | | | | | | | |
| 18 | Fire. | | | | | | | | | | | |
| 21 | Exposure to physical agents (noise) | | | | | | | | | | | |
| 21 | Exposure to physical agents (vibration) | | | | | | | | | | | |
| 22 | Exposure to chemical agents | | | | | | | | | | | |
| 27 | Other (Flooding). | | | | | | | | | | | |

| Consequence | | | | Probability | | | | Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| L | Light | G | Serious | B | Low | A | High | T | Trivial | I | Important |
| S | Severe | | | M | Medium | | | TO | Tolerable | IN | Intolerable |
| | | | | | | | | M | Moderate | | |

**Preventive measures**
Provide onboard the instruction manuals for handling and maintaining the machinery and equipment (in the language of the crew). (10,11,14,16,18,21)
All operations for maintenance, repair, greasing and cleaning will be carried out with the engines stopped ... (Royal Decree 1215/1997) (07,09,10,11,14,15,16,18,21).
Provide correct illumination and natural ventilation (sufficient to prevent the accumulation of fumes from fuel, etc., in normal conditions). If necessary install smoke and gas extractors. (18.22).
Keep closed the place where the engine is installed, while the vessel is under way. (18,21).
Keep vessel clean and tidy, and prevent fuel spills. (02,07,09,18).
Where leaks may occur, with the risk that fluids may come into contact with hot surfaces, appropriate guards or screens will be installed. (10,11,14,15,16,18).
All apertures should be capable of being closed automatically in the event of fire (18).
Identification and marking of pipes and valves. The pipes should be marked with appropriate colours. (18,22).
Correct placing of corresponding fire extinguishers. (SOLAS) (18).
Provide the necessary means of pumping. (27).
Make noise measurements periodically. (21).

| Personal protective gear | Measures for collective protection |
|---|---|
| Gloves for protection against mechanical risks, EN 388<br>Protective mask for gases and organic vapours, A2 EN 405.<br>Hearing protectors, EN 352/2. | Ventilation systems, smoke extractors.<br>Alarms to warn of fire and entry of water.<br>Sound insulation in the engine room. |

**Assessment criteria:**
Law 31/1995, of 8 November, for the Prevention of Occupational Risks. Royal Decree 1215/1997, of 18 April, on the minimum prov isions for health and safety in respect of the utilisation by employees of personal protective gear. Royal Decree 374/2001, of 6 May, on the protection of the health and safety of employees against the risks related to chemical agents at work. Royal Decree 614/2001, of 8 June, on the minimum provisions for the protection of the health and safety of employees against electrical risks. Royal Decree 286/2006, of 10 March, on the protection of the health and safety of employees against the risks related to exposure to noise at work. Complementary rules of the International Convention on the Safety of Human Life at Sea (SOLAS), 1986.
Technical criteria

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